



# CHAPTER WISE TOPIC WISE NOTES CLASS IX MATHEMATICS



## Include

1. Daily Practice Paper
2. NCERT Solutions
3. NCERT Exemplars
4. Chapter Wise Mind Maps

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AS PER LATEST CBSE CURRICULUM 2024-25

## Chapter 5: Introduction To Euclid's Geometry

### Concepts Covered:

1. **Introduction to Euclid's Geometry**
    - Thales Theorem
    - Euclid's elements
    - Geometry in architecture
    - Geometry in navigation
  2. **Euclid's Definitions, Axioms and Postulates**
  3. **Equivalent Versions of Euclid's Fifth Postulate**
    - The fifth postulate
    - Play fair's Axiom
    - Two distinct intersecting lines cannot be parallel to the same line
  4. **Mind Map**  
(Colourful & Interactive/ Complete All Concept Covered)
- Practice Questions (All Topics Available)**

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**INTRODUCTION TO EUCLID'S GEOMETRY****INTRODUCTION TO EUCLID'S GEOMETRY****INTRODUCTION TO EUCLID'S GEOMETRY****Introduction**

The word 'geometry' comes from the Greek word 'geo', meaning the 'earth' and 'metron' meaning to measure. Thus, the word 'geometry' means 'earth measurement'.

Ancient Egyptians were known to be the first people to study geometry.

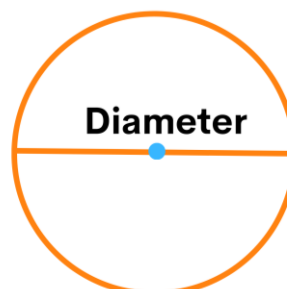
Euclid was a teacher of mathematics at Alexandria in Egypt, popularly known as "Father of Geometry".

He introduced the method of proving mathematical results by using deductive logical reasoning and the previously proved result.

He collected all his work in a book called "Elements". This book is divided into thirteen chapters and each chapter is called a book.

**Thales Theorem:**

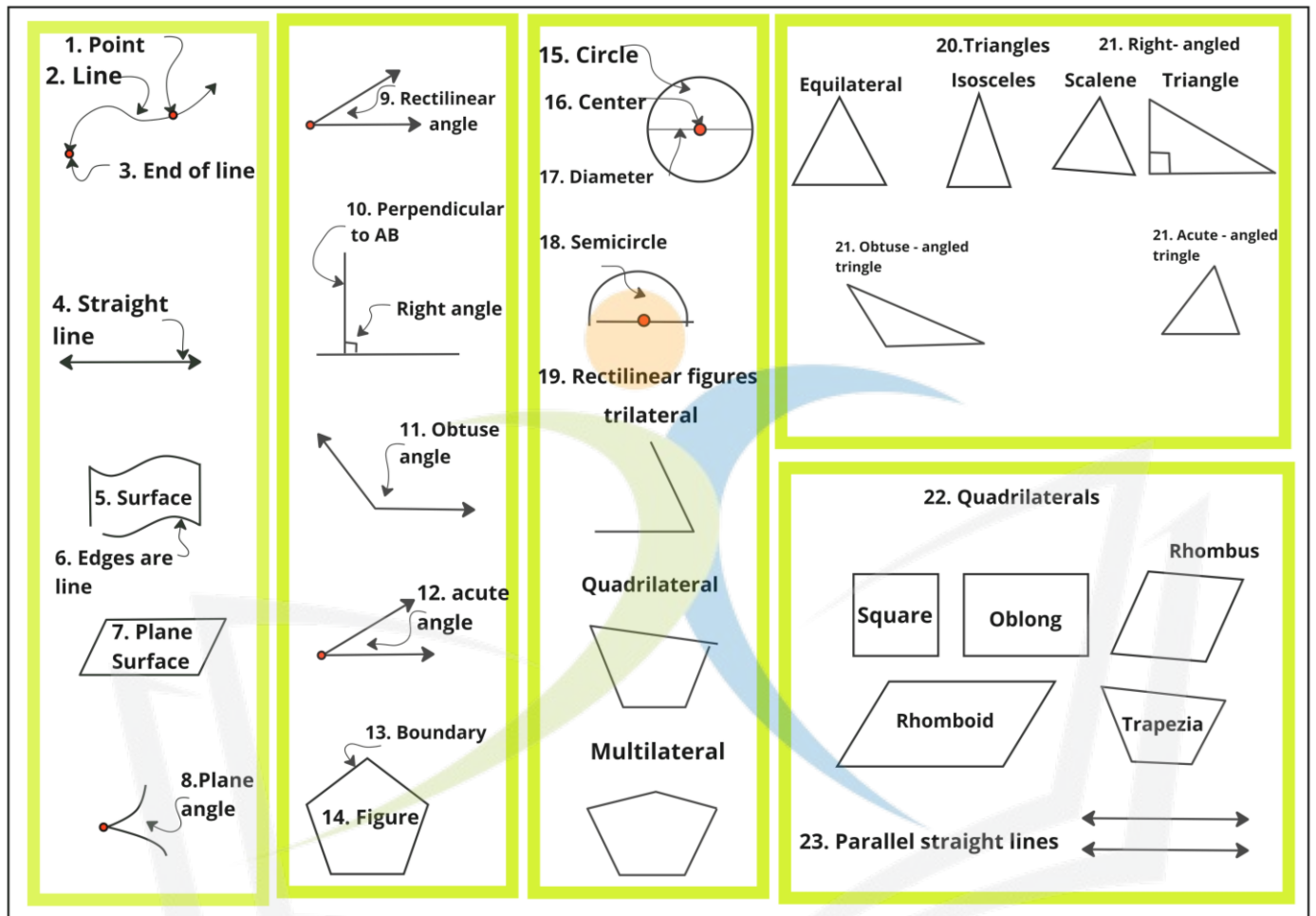
Thales' Theorem states that if three points lie on a circle, and one of the points forms a diameter of the circle.

**Diameter of a Circle**

# INTRODUCTION TO EUCLID'S GEOMETRY

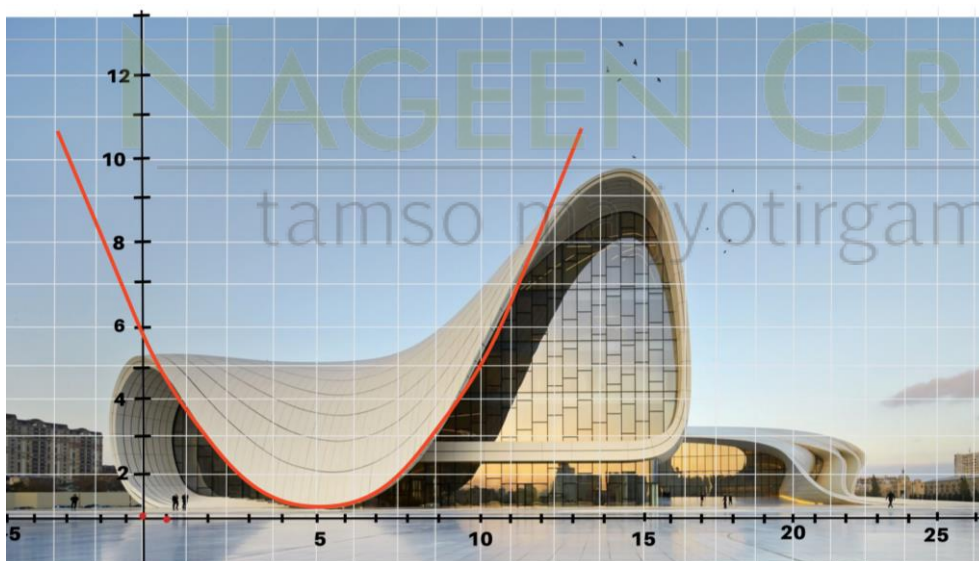
## INTRODUCTION TO EUCLID'S GEOMETRY

### Euclid's elements:



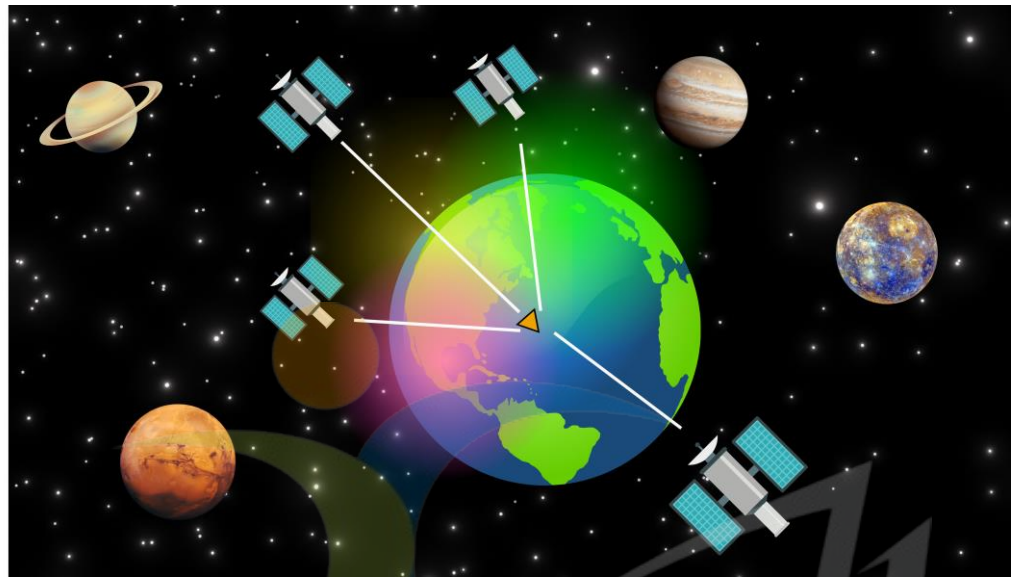
Exploring real-life examples where Euclidean geometry concepts are used.

### Geometry in architecture:



## INTRODUCTION TO EUCLID'S GEOMETRY

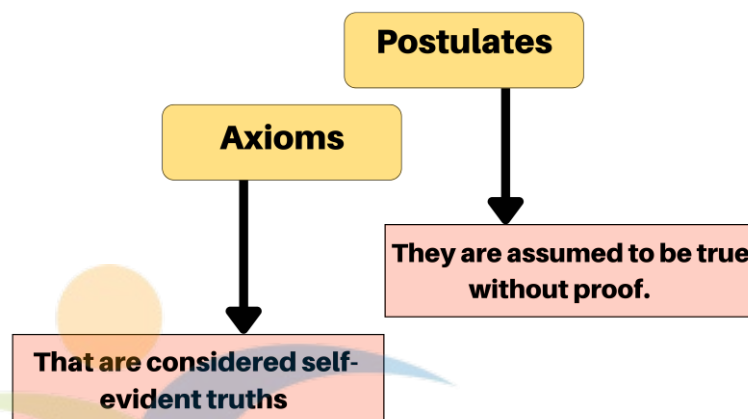
## INTRODUCTION TO EUCLID'S GEOMETRY

Geometry in navigation:

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## INTRODUCTION TO EUCLID'S GEOMETRY

## EUCLID'S DEFINITIONS, AXIOMS AND POSTULATES

EUCLID'S DEFINITIONS, AXIOMS AND POSTULATESDefinitions of Euclid's:

Euclid thought that the geometry is an abstract model of the world which we can see around us. Like the notions of line, plane, surface etc.

He had given these notions in the form of definitions:

- Anything which has no component is called Point.
- A length without breadth is called Line.
- The endpoints of any line are called Points which make it line segment.
- If a line lies evenly with the points on itself, then it is called A Straight Line.
- Any object which has length and breadth only is called Surface.
- The edges of a surface are lines.
- A plane surface is a surface which lies evenly with the straight lines on itself.

Axioms And Postulates:

**Axioms:** Some common notions which are used in mathematics but not directly related to mathematics are called Axioms.

Some of the Axioms are:

1. If the two things are equal to a common thing, then these are equal to one another.

If  $p = q$  and  $s = q$ , then  $p = s$ .

2. If equals are added to equals, the wholes are equal.

If  $p = q$  and we add  $s$  to both  $p$  and  $q$  then the result will also be equal.

$$p + s = q + s$$

3. If equals are subtracted from equals, the remainders are equal.



## INTRODUCTION TO EUCLID'S GEOMETRY

## EUCLID'S DEFINITIONS, AXIOMS AND POSTULATES

This is same as above, if  $p = q$  and we subtract the same number from both then the result will be the same.

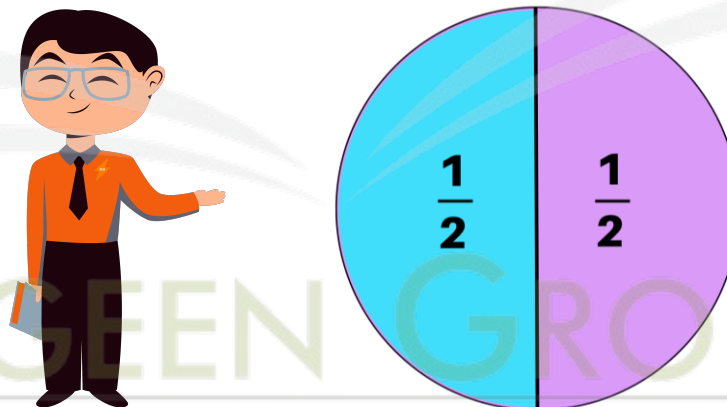
$$p - s = q - s$$

4. Things which coincide with one another are equal to one another. If two figures fit into each other completely then these must be equal to one another.
5. The whole is greater than the part.



This circle is divided into four parts and each part is smaller than the whole circle. This shows that the whole circle will always be greater than any of its parts.

6. Things which are double of the same things are equal to one another.



This shows that this is the double of the two semicircles, so the two semicircles are equal to each other.

7. Things which are halves of the same things are equal to one another. This is the vice versa of the above axiom.

**Postulates:**

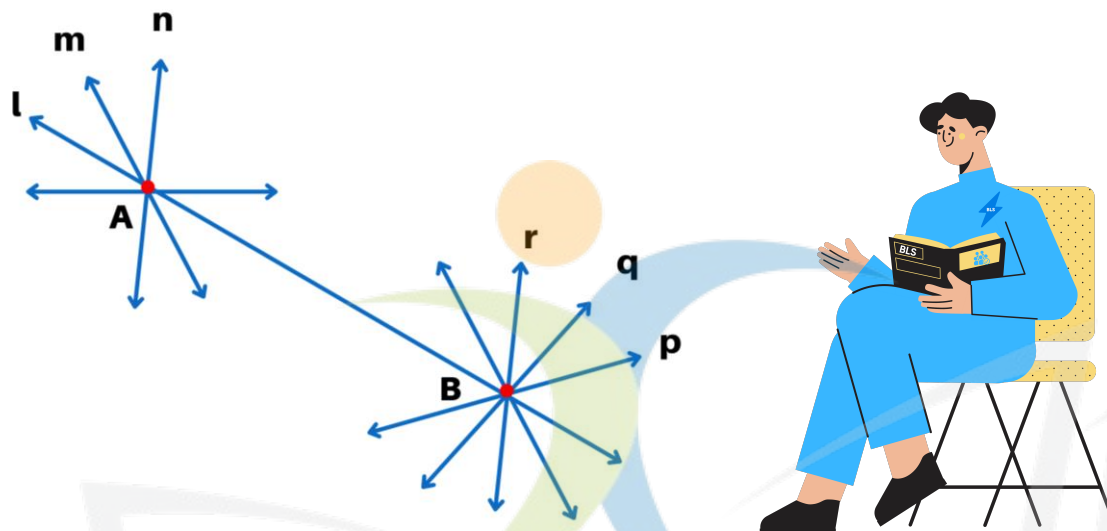
The assumptions which are very specific in geometry are called Postulates.

**There are five postulates by Euclid:**

## INTRODUCTION TO EUCLID'S GEOMETRY

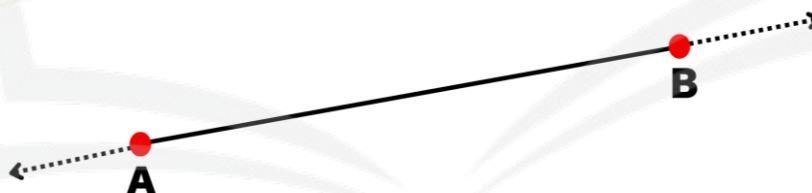
## EUCLID'S DEFINITIONS, AXIOMS AND POSTULATES

**Postulate 1:** A straight line may be drawn from any one point to any other point. This postulate tells us that at least one straight line passes through two distinct points, but it does not say that there cannot be more than one such line.



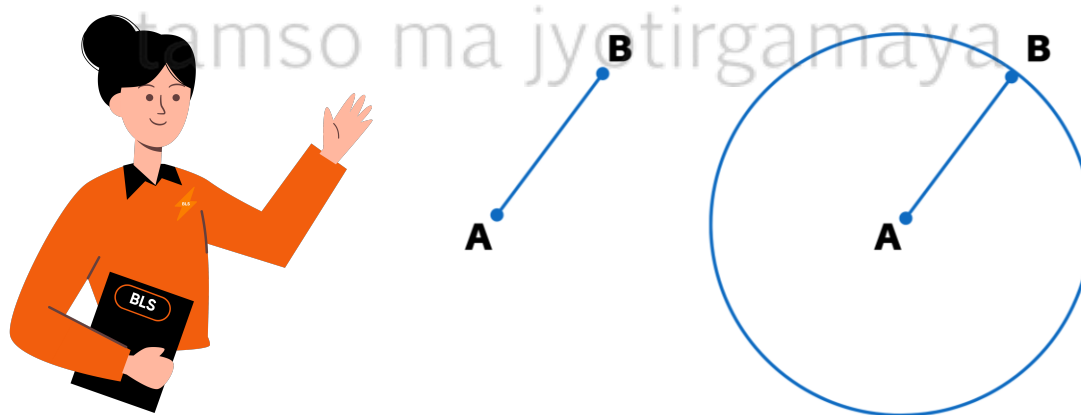
This shows that a line can be drawn from point A to point B, but it doesn't mean that there could not be other lines from these points.

**Postulate 2:** A terminated line can be produced indefinitely.



This shows that a line segment which has two endpoints can be extended indefinitely to form a line.

**Postulate 3:** A circle can be drawn with any center and any radius.

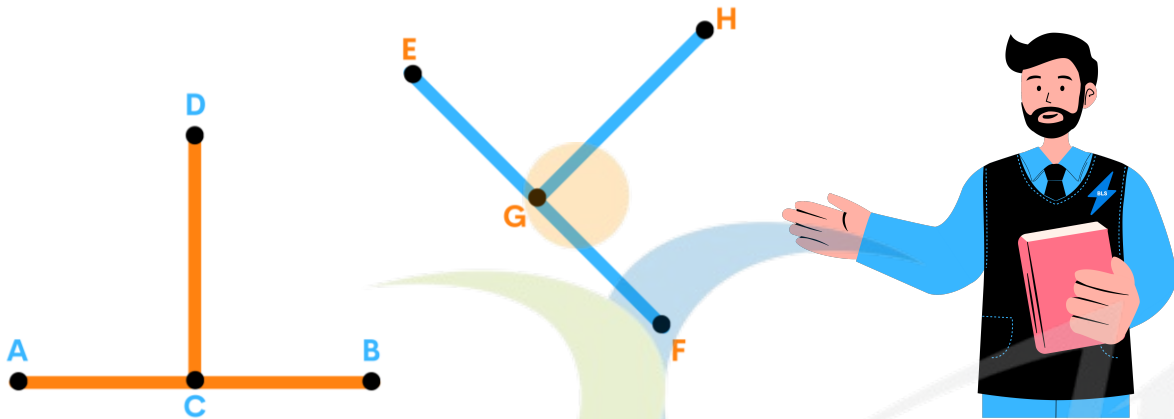


## INTRODUCTION TO EUCLID'S GEOMETRY

## EUCLID'S DEFINITIONS, AXIOMS AND POSTULATES

This shows that we can draw a circle with any line segment by taking one of its points as a centre and the length of the line segment as the radius. As we have AB line segment, in which we took A as the centre and the AB as the radius of the circle to form a circle.

**Postulate 4:** All right angles are equal to one another.

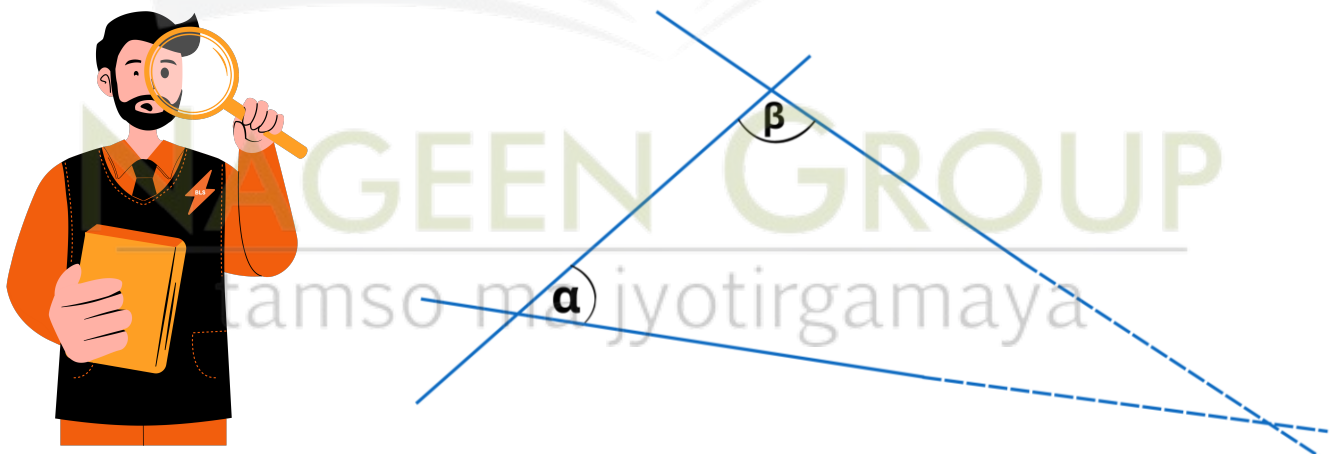


As we know that a right angle is equal to  $90^\circ$  and all the right angles are congruent because if any angle is not  $90^\circ$  then it is not a right angle.

As in the above figure

$$\angle DCA = \angle DCB = \angle HE = \angle HGF = 90^\circ$$

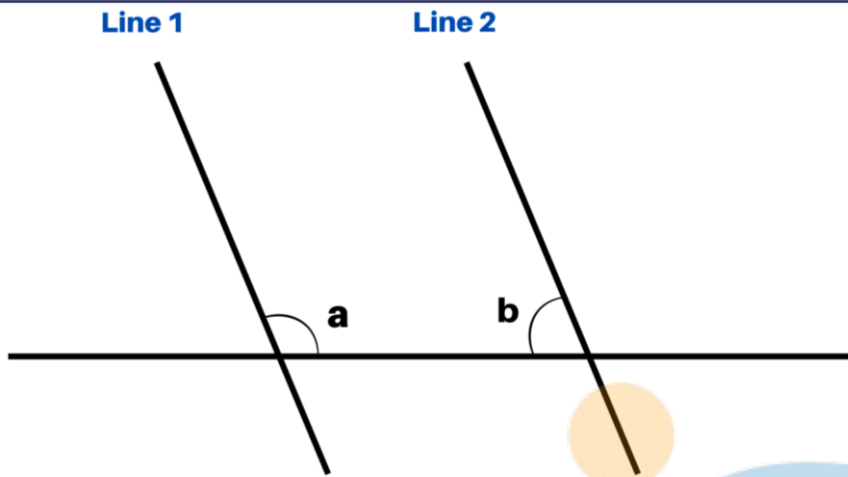
**Postulate 5:** If there is a line segment which passes through two straight lines while forming two interior angles on the same side whose sum is less than  $180^\circ$ , then these two lines will definitely meet with each other if extended on the side where the sum of two interior angles is less than two right angles.



And if the sum of the two interior angles on the same side is  $180^\circ$  then the two lines will be parallel to each other.

## INTRODUCTION TO EUCLID'S GEOMETRY

## EUCLID'S DEFINITIONS, AXIOMS AND POSTULATES



If:  $a + b = 180^\circ$

Then: Line 1 and Line 2 are parallel.

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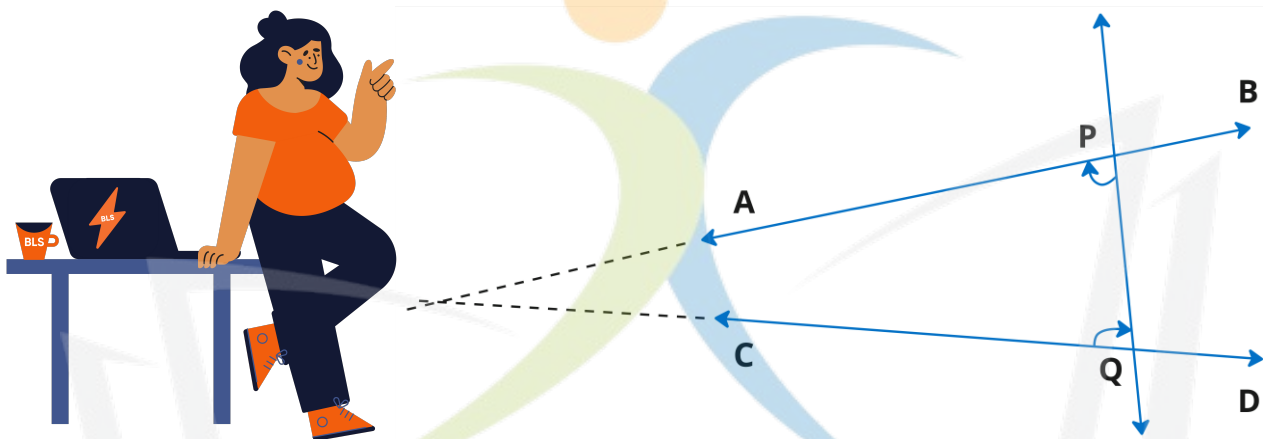
## INTRODUCTION TO EUCLID'S GEOMETRY

## EQUIVALENT VERSIONS OF EUCLID'S FIFTH POSTULATE

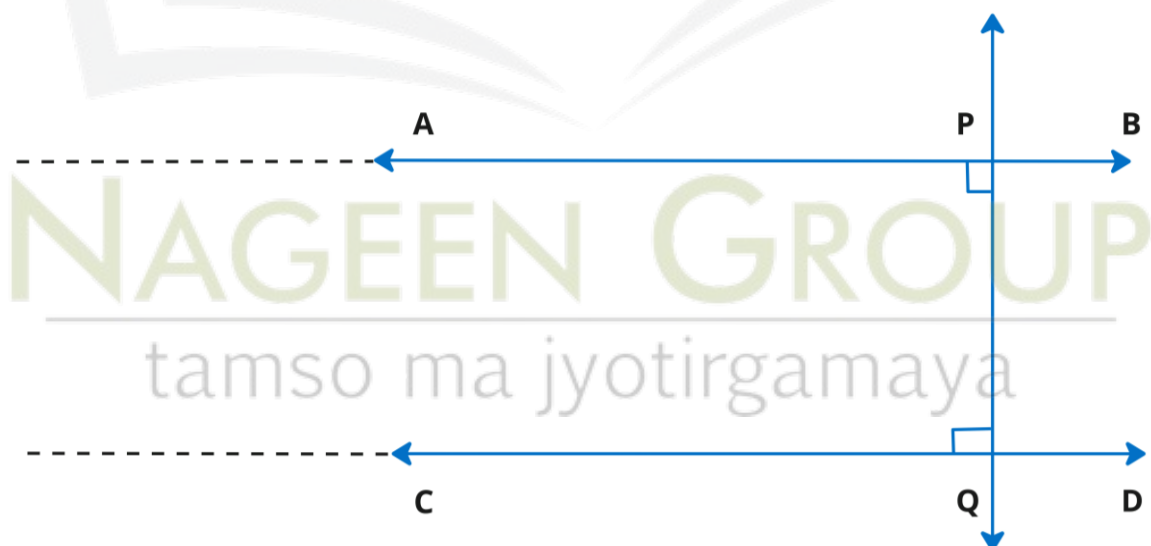
EQUIVALENT VERSIONS OF EUCLID'S FIFTH POSTULATE**The fifth postulate**

"If a straight line falling on two straight lines makes the interior angles on the same side of it taken together less than two right angles, then the two straight lines, if produced indefinitely, meet on that side on which the sum of angles is less than two right angles."

This postulate holds a significant place in the history of mathematics.



We can see in the figure that both the interior angles are less than  $90^\circ$ . So, their sum must be less than  $180^\circ$ . So, when they are extended they intersect at a particular point. This won't happen if the internal angles are  $90^\circ$  or greater than  $90^\circ$ .

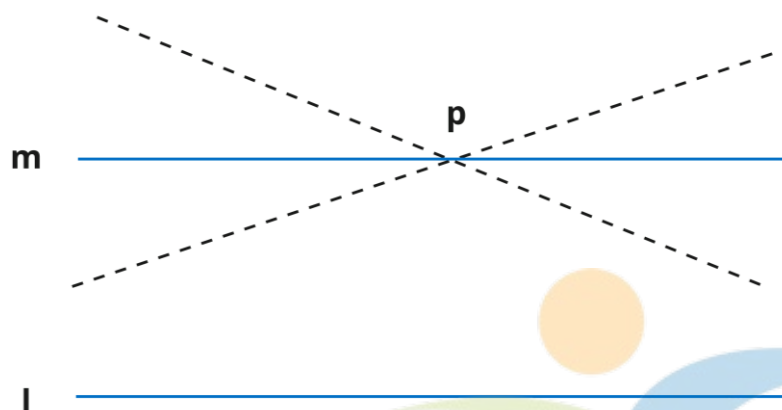
**Playfair's Axiom**

"For every line "l" and for every point "P" lying not on "l", there exists a unique line "m" passing through P and parallel to "l".

## INTRODUCTION TO EUCLID'S GEOMETRY

## EQUIVALENT VERSIONS OF EUCLID'S FIFTH POSTULATE

Two distinct intersecting lines cannot be parallel to the same line



**“Two distinct intersecting lines cannot be parallel to the same line.”**

**Note (Fact):** Euclid did not require the fifth postulate to prove his first 28 theorems. Many mathematicians including Euclid were convinced that the fifth postulate is actually a theorem that can not be proved. Several attempts were made but no one was able to prove the fifth postulate.

**Example 1:** Harsh's salary equal to Ram's salary. Due to the Covid-19 recession, Harsh and Ram's salaries are made half. The final salary of Ram will still be equal to Harsh. This is as per

- 1st Axiom.
- 7th Axiom.
- 6th Axiom.
- 2nd Axiom.

**Solution:** 7th Axiom states that,

“Things which are halves of the same things are equal to one another.”

This axiom can be applied here directly. Thus, the answer is (b).

**Example 2:** Boundaries of Solids are:

- Lines
- Points
- Surface
- Curves

**Solution:** According to Euclid's definition,

“A solid has shape, size, position, and can be moved from one place to another. Its boundaries are called surfaces. They separate one part of the space from another and are said to have no thickness. The boundaries of the surfaces are curves or straight lines. These lines end in points.”

This definition states that boundaries of solids are called surfaces.



## Introduction to Euclid's Geometry

### DPP-01

[Topic: Euclid's Definitions, Axioms and Postulates]

#### Very Short Answer Type Questions

1. How many dimensions does a point have?
2. How many dimensions does a solid have?
3. State Euclid's fifth axiom.
4. Define theorem.
5. In which form it is stated that 'Two intersecting lines cannot be parallel to the same line'?
6. It is known that if  $x + y = 10$ , then  $x + y + z = 10 + z$ . Which axiom of Euclid does this statement illustrate?
7. In which form Euclid stated that all right angles are equal to each other?
8. What can you say about things which are double of same thing?
9. If a point  $P$  lies in between  $A$  and  $B$ , then find  $AP + PB$ .
10. In the given figure, if  $AD = BC$ , then compare  $AC$  and  $BD$ .



#### Short Answer Type Questions-I

11. Which of the following statements are true and which are false? Give reasons for your answers.
  - (i) Only one line can pass through a single point.
  - (ii) There are infinite number of lines which pass through two distinct points.
  - (iii) A terminated line can be produced indefinitely on both the sides.
  - (iv) If two circles are equal, then their radii are equal.
  - (v) In the given figure, if  $AB = PQ$  and  $PQ = XY$ , then  $AB = XY$ .

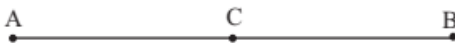


12. In the given figure, if  $AC = BD$ , show that  $AB = CD$ . State the Euclid's postulate/axiom used for the same.



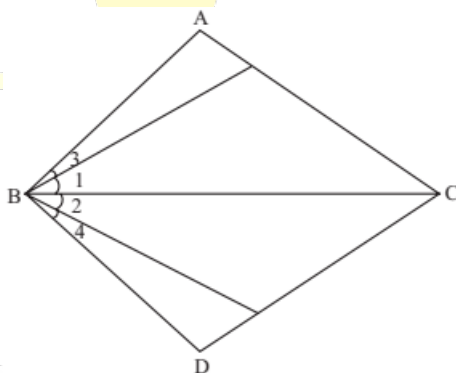
13. If a point  $C$  lies between two points  $A$  and  $B$  such that it is the mid-point of line segment  $AB$ , prove that every line segment has one and only one mid-point.

14. In the given figure, if point C lies between A and B, then prove that  $AB > AC$ . Which Euclid's axiom is applied by you?



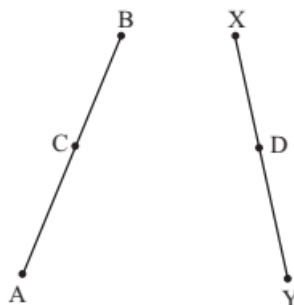
15. Solve the equation  $x + 4 = 10$  and state Euclid's axiom used.

16. In the given figure,  $\angle 1 = \angle 2$  and  $\angle 3 = \angle 4$ . Show that  $\angle ABC = \angle DBC$ . State the Euclid's axiom used.



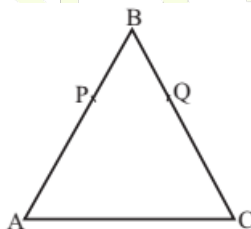
### Short Answer Type Questions-II

17. In the given figure,  $AC = XD$ , C is the mid-point of AB and D is the mid-point of XY. Using an Euclid's axiom, show that  $AB = XY$ .



18. Prove that an equilateral triangle can be constructed on any given line segment.

19. In the given figure,  $AB = BC$  and  $BP = BQ$ . Show that  $AP = CQ$ .



20. Read the following statement:

"A square is a polygon made up of four line segments, out of which, length of three line segments are equal to the length of fourth one and all its angles are right angles."

Define the terms used in this definition which you feel are necessary. Are there any undefined terms in this? Can you justify that all angles and sides of a square are equal?

21. Consider two 'postulates' given below:

- (i) Given any two distinct points A and B, there exists a third point C which is in between A and B.
- (ii) There exist at least three points that are not on the same line.

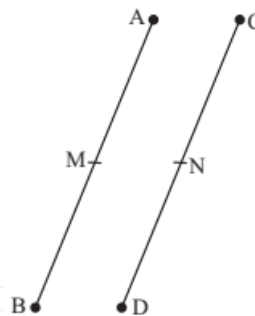
Do these postulates contain any undefined terms? Are these postulates consistent? Do they follow from Euclid's postulates? Explain.

22. A company manufactures circular teethers of good quality for the little kids in three different sizes. If first is greater than second and second is greater than third, then

- (i) How are first and third related?
- (ii) There exist two types of machines for manufacturing teethers, one operates on electricity and other on coal. Which machine would you prefer?

23. In a society, the number of persons using CNG instead of petrol for their vehicles has increased by 15 and now the number is 25. Form a linear equation to find the original number of persons using CNG and solve it using Euclid's axiom. Which value is depicted by the society?

24. A teacher holds two sticks, AB and CD of equal length in her hands and marked their mid-points M and N respectively. She then asked the students whether AM is equal to ND or not. Shreya answered, yes. Is Shreya correct? State the axiom of Euclid that supports her answer.



Which values of Shreya are depicted here?

## INTRODUCTION TO EUCLID'S GEOMETRY

## INTRODUCTION TO EUCLID'S GEOMETRY


## (Practice Sheet)

- 1 Who is known as the "Father of Geometry"?
  - A. Thales
  - B. Pythagoras
  - C. Euclid
  - D. Aristotle
- 2 Where did Euclid teach mathematics?
  - A. Athens
  - B. Rome
  - C. Alexandria
  - D. Cairo
- 3 What is the name of Euclid's famous book that collected all his work?
  - A. Mathematics Essentials
  - B. Geometric Principles
  - C. Elements
  - D. Theorems and Proofs
- 4 How many chapters is Euclid's "Elements" divided into?
  - A. Seven
  - B. Ten
  - C. Thirteen
  - D. Fifteen
- 5 Which theorem states that if three points lie on a circle, and one of the points forms a diameter of the circle?
  - A. Pythagorean Theorem
  - B. Thales' Theorem
  - C. Euclidean Theorem
  - D. Circle Theorem
- 6 Discuss the significance of Euclid's "Elements" in the history of mathematics.
- 7 How does Euclidean geometry differ from other approaches to geometry?
- 8 Name three contributions of Euclid to the field of mathematics.
- 9 Discuss the historical context of Euclid's work in Alexandria.
- 10 Investigate the impact of Thales' Theorem on modern geometry.

## INTRODUCTION TO EUCLID'S GEOMETRY

## EUCLID'S DEFINITIONS, AXIOMS AND POSTULATES

## (Practice Sheet)

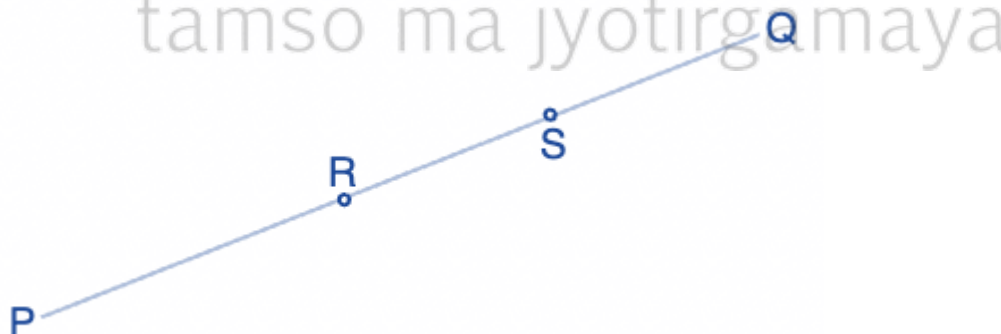
- 1 What is a Point in Euclidean geometry?
  - A. A length without breadth
  - B. An object with length and breadth only
  - C. Anything with no component
  - D. The edges of a surface
- 2 How does Euclid define a Surface?
  - A. A length without breadth
  - B. Anything with no component
  - C. An object with length and breadth only
  - D. The edges of a surface are lines
- 3 Which axiom states, "If equals are subtracted from equals, the remainders are equal"?
  - A. Axiom of equality
  - B. Axiom of addition
  - C. Axiom of subtraction
  - D. Axiom of coincidence
- 4 What does Euclid's Postulate 3 state?
  - A. A circle can be drawn with any center and any radius.
  - B. All right angles are equal to one another.
  - C. A straight line may be drawn from any one point to any other point.
  - D. A terminated line can be produced indefinitely.
- 5 According to Euclid, when are two lines parallel?
  - A. If the sum of the interior angles is  $90^\circ$
  - B. If the sum of the interior angles is  $180^\circ$
  - C. If the sum of the interior angles is less than  $180^\circ$
  - D. If the sum of the interior angles is greater than  $180^\circ$
- 6 How much lines can pass from one point?
- 7 How much lines can pass from two distinct points?
- 8 Define a Straight Line according to Euclid.
- 9 Bella marked three points A, B, and C on a line such that, B lies between A and C. Help Bella prove that  $AB + BC = AC$ .
 
- 10 Prove that an equilateral triangle can be constructed on any given line segment.

## INTRODUCTION TO EUCLID'S GEOMETRY

## EQUIVALENT VERSIONS OF EUCLID'S FIFTH POSTULATE

## (Practice Sheet)

- 1 According to Euclid's fifth postulate, two straight lines, when extended indefinitely, meet on the side where the sum of interior angles is:
  - A. Less than a right angle
  - B. Equal to a right angle
  - C. Greater than a right angle
  - D. Equal to two right angles
- 2 Euclid's first 28 theorems did not require the fifth postulate. This suggests that:
  - A. The fifth postulate is not important.
  - B. The fifth postulate is redundant.
  - C. The fifth postulate is actually a theorem.
  - D. The fifth postulate is false.
- 3 According to Euclid's definition, the boundaries of solids are called:
  - A. Lines
  - B. Points
  - C. Surface
  - D. Curves
- 4 Playfair's Axiom states that for every line "l" and every point "P" not lying on "l," there exists a unique line "m" passing through P and parallel to "l." This implies that:
  - A. Two distinct intersecting lines are always parallel.
  - B. Two distinct intersecting lines cannot be parallel.
  - C. Every line has a unique parallel line.
  - D. Parallel lines never intersect.
- 5 What is Euclid's Fifth Postulate concerned with?
  - A. Lines and points
  - B. Angles in a triangle
  - C. Parallel lines
  - D. Circles and arcs
- 6 Read the following axioms:
  - (i) Things which are equal to the same thing are equal to one another.
  - (ii) If equals are added to equals, the wholes are equal.
  - (iii) Things which are double of the same thing are equal to one another.
 Check whether the given system of axioms is consistent or inconsistent
- 7 Explain why Euclid's Fifth Postulate is considered a theorem that cannot be proved.
- 8 In the figure given below, the line-segment has  $PS = RQ$ . Prove that  $PR = SQ$ .



- 9 It is known that  $a + b = 18$ , and  $a = c$ . Prove that  $c + b = 18$ .

## INTRODUCTION TO EUCLID'S GEOMETRY

## EQUIVALENT VERSIONS OF EUCLID'S FIFTH POSTULATE

**10** It is known  $a + b = 11$ , then  $a + b + c = 11 + c$ . The Euclid axioms that illustrate this statement is,

- 1<sup>st</sup> axiom.
- 3<sup>rd</sup> axiom
- 4<sup>th</sup> axiom
- 2<sup>nd</sup> axiom



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## Introduction to Euclid's Geometry

### DPP-01

[Topic: Euclid's Definitions, Axioms and Postulates]

#### Very Short Answer Type Questions

1. How many dimensions does a point have?
2. How many dimensions does a solid have?
3. State Euclid's fifth axiom.
4. Define theorem.
5. In which form it is stated that 'Two intersecting lines cannot be parallel to the same line'?
6. It is known that if  $x + y = 10$ , then  $x + y + z = 10 + z$ . Which axiom of Euclid does this statement illustrate?
7. In which form Euclid stated that all right angles are equal to each other?
8. What can you say about things which are double of same thing?
9. If a point  $P$  lies in between  $A$  and  $B$ , then find  $AP + PB$ .
10. In the given figure, if  $AD = BC$ , then compare  $AC$  and  $BD$ .



#### Short Answer Type Questions-I

11. Which of the following statements are true and which are false? Give reasons for your answers.
  - (i) Only one line can pass through a single point.
  - (ii) There are infinite number of lines which pass through two distinct points.
  - (iii) A terminated line can be produced indefinitely on both the sides.
  - (iv) If two circles are equal, then their radii are equal.
  - (v) In the given figure, if  $AB = PQ$  and  $PQ = XY$ , then  $AB = XY$ .

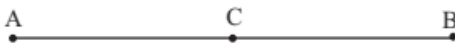


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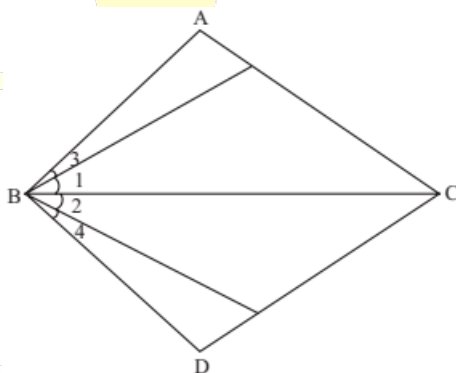
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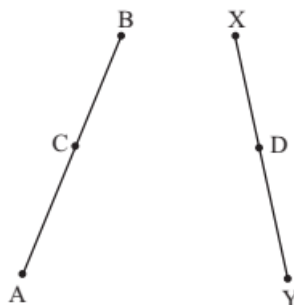
15. Solve the equation  $x + 4 = 10$  and state Euclid's axiom used.

16. In the given figure,  $\angle 1 = \angle 2$  and  $\angle 3 = \angle 4$ . Show that  $\angle ABC = \angle DCB$ . State the Euclid's axiom used.



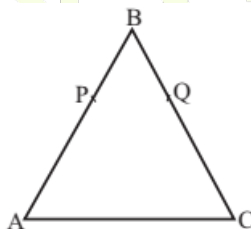
### Short Answer Type Questions-II

17. In the given figure,  $AC = XD$ , C is the mid-point of AB and D is the mid-point of XY. Using an Euclid's axiom, show that  $AB = XY$ .



18. Prove that an equilateral triangle can be constructed on any given line segment.

19. In the given figure,  $AB = BC$  and  $BP = BQ$ . Show that  $AP = CQ$ .



20. Read the following statement:

"A square is a polygon made up of four line segments, out of which, length of three line segments are equal to the length of fourth one and all its angles are right angles."

Define the terms used in this definition which you feel are necessary. Are there any undefined terms in this? Can you justify that all angles and sides of a square are equal?

21. Consider two 'postulates' given below:

- (i) Given any two distinct points A and B, there exists a third point C which is in between A and B.
- (ii) There exist at least three points that are not on the same line.

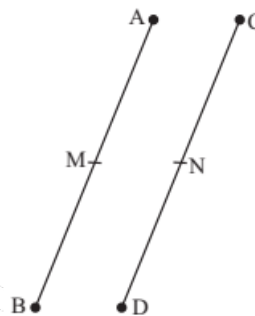
Do these postulates contain any undefined terms? Are these postulates consistent? Do they follow from Euclid's postulates? Explain.

22. A company manufactures circular teethers of good quality for the little kids in three different sizes. If first is greater than second and second is greater than third, then

- (i) How are first and third related?
- (ii) There exist two types of machines for manufacturing teethers, one operates on electricity and other on coal. Which machine would you prefer?

23. In a society, the number of persons using CNG instead of petrol for their vehicles has increased by 15 and now the number is 25. Form a linear equation to find the original number of persons using CNG and solve it using Euclid's axiom. Which value is depicted by the society?

24. A teacher holds two sticks, AB and CD of equal length in her hands and marked their mid-points M and N respectively. She then asked the students whether AM is equal to ND or not. Shreya answered, yes. Is Shreya correct? State the axiom of Euclid that supports her answer.



Which values of Shreya are depicted here?

**INTRODUCTION TO EUCLID'S GEOMETRY****INTRODUCTION TO EUCLID'S GEOMETRY****(Practice Sheet)**


- 1 Who is known as the "Father of Geometry"?**  
A. Thales  
B. Pythagoras  
C. Euclid  
D. Aristotle
- 2 Where did Euclid teach mathematics?**  
A. Athens  
B. Rome  
C. Alexandria  
D. Cairo
- 3 What is the name of Euclid's famous book that collected all his work?**  
A. Mathematics Essentials  
B. Geometric Principles  
C. Elements  
D. Theorems and Proofs
- 4 How many chapters is Euclid's "Elements" divided into?**  
A. Seven  
B. Ten  
C. Thirteen  
D. Fifteen
- 5 Which theorem states that if three points lie on a circle, and one of the points forms a diameter of the circle?**  
A. Pythagorean Theorem  
B. Thales' Theorem  
C. Euclidean Theorem  
D. Circle Theorem
- 6** Discuss the significance of Euclid's "Elements" in the history of mathematics.
- 7** How does Euclidean geometry differ from other approaches to geometry?
- 8** Name three contributions of Euclid to the field of mathematics.
- 9** Discuss the historical context of Euclid's work in Alexandria.
- 10** Investigate the impact of Thales' Theorem on modern geometry.

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## INTRODUCTION TO EUCLID'S GEOMETRY

## EUCLID'S DEFINITIONS, AXIOMS AND POSTULATES

## (Practice Sheet)

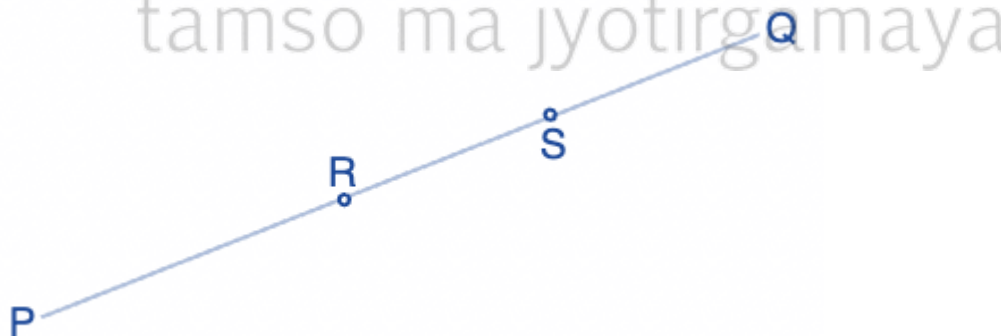
- 1 What is a Point in Euclidean geometry?
  - A. A length without breadth
  - B. An object with length and breadth only
  - C. Anything with no component
  - D. The edges of a surface
- 2 How does Euclid define a Surface?
  - A. A length without breadth
  - B. Anything with no component
  - C. An object with length and breadth only
  - D. The edges of a surface are lines
- 3 Which axiom states, "If equals are subtracted from equals, the remainders are equal"?
  - A. Axiom of equality
  - B. Axiom of addition
  - C. Axiom of subtraction
  - D. Axiom of coincidence
- 4 What does Euclid's Postulate 3 state?
  - A. A circle can be drawn with any center and any radius.
  - B. All right angles are equal to one another.
  - C. A straight line may be drawn from any one point to any other point.
  - D. A terminated line can be produced indefinitely.
- 5 According to Euclid, when are two lines parallel?
  - A. If the sum of the interior angles is  $90^\circ$
  - B. If the sum of the interior angles is  $180^\circ$
  - C. If the sum of the interior angles is less than  $180^\circ$
  - D. If the sum of the interior angles is greater than  $180^\circ$
- 6 How much lines can pass from one point?
- 7 How much lines can pass from two distinct points?
- 8 Define a Straight Line according to Euclid.
- 9 Bella marked three points A, B, and C on a line such that, B lies between A and C. Help Bella prove that  $AB + BC = AC$ .
 
- 10 Prove that an equilateral triangle can be constructed on any given line segment.

## INTRODUCTION TO EUCLID'S GEOMETRY

## EQUIVALENT VERSIONS OF EUCLID'S FIFTH POSTULATE

## (Practice Sheet)

- 1 According to Euclid's fifth postulate, two straight lines, when extended indefinitely, meet on the side where the sum of interior angles is:
  - A. Less than a right angle
  - B. Equal to a right angle
  - C. Greater than a right angle
  - D. Equal to two right angles
- 2 Euclid's first 28 theorems did not require the fifth postulate. This suggests that:
  - A. The fifth postulate is not important.
  - B. The fifth postulate is redundant.
  - C. The fifth postulate is actually a theorem.
  - D. The fifth postulate is false.
- 3 According to Euclid's definition, the boundaries of solids are called:
  - A. Lines
  - B. Points
  - C. Surface
  - D. Curves
- 4 Playfair's Axiom states that for every line "l" and every point "P" not lying on "l," there exists a unique line "m" passing through P and parallel to "l." This implies that:
  - A. Two distinct intersecting lines are always parallel.
  - B. Two distinct intersecting lines cannot be parallel.
  - C. Every line has a unique parallel line.
  - D. Parallel lines never intersect.
- 5 What is Euclid's Fifth Postulate concerned with?
  - A. Lines and points
  - B. Angles in a triangle
  - C. Parallel lines
  - D. Circles and arcs
- 6 Read the following axioms:
  - (i) Things which are equal to the same thing are equal to one another.
  - (ii) If equals are added to equals, the wholes are equal.
  - (iii) Things which are double of the same thing are equal to one another.
 Check whether the given system of axioms is consistent or inconsistent
- 7 Explain why Euclid's Fifth Postulate is considered a theorem that cannot be proved.
- 8 In the figure given below, the line-segment has  $PS = RQ$ . Prove that  $PR = SQ$ .



- 9 It is known that  $a + b = 18$ , and  $a = c$ . Prove that  $c + b = 18$ .

## INTRODUCTION TO EUCLID'S GEOMETRY

## EQUIVALENT VERSIONS OF EUCLID'S FIFTH POSTULATE

**10** It is known  $a + b = 11$ , then  $a + b + c = 11 + c$ . The Euclid axioms that illustrate this statement is,

- 1<sup>st</sup> axiom.
- 3<sup>rd</sup> axiom
- 4<sup>th</sup> axiom
- 2<sup>nd</sup> axiom



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**EXERCISE 5.1**

Write the correct answer in each of the following:

1. The three steps from solids to points are:

- (A) Solids - surfaces - lines - points
- (B) Solids - lines - surfaces - points
- (C) Lines - points - surfaces - solids
- (D) Lines - surfaces - points - solids

**Solution:**

- (A) Solids - surfaces - lines - points

Explanation:

The three steps from solids to point are solids-surfaces-lines-points.  
Hence, option (A) is the correct answer.

2. The number of dimensions, a solid has:

- (A) 1
- (B) 2
- (C) 3
- (D) 0

**Solution:**

- (C) 3

Explanation:

The number of dimensions, a solid has is 3.  
Hence, option (C) is the correct answer.

3. The number of dimensions, a surface has:

- (A) 1
- (B) 2
- (C) 3
- (D) 0

**Solution:**

- (B) 2

Explanation:

The number of dimensions, a surface has is 2.  
Hence, option (B) is the correct answer.

4. The number of dimension, a point has:

- (A) 0
- (B) 1
- (C) 2
- (D) 3

**Solution:**

- (A) 0

Explanation:

The number of dimension, a point has is 0.  
Hence, option (A) is the correct answer.

**5. Euclid divided his famous treatise “The Elements” into:**

- (A) 13 chapters
- (B) 12 chapters
- (C) 11 chapters
- (D) 9 chapters

**Solution:**

- (A) 13 chapters

Explanation:

Euclid divided his famous treatise “The Elements” into 13 chapters.  
Hence, option (A) is the correct answer.

**6. The total number of propositions in the Elements are:**

- (A) 465
- (B) 460
- (C) 13
- (D) 55

**Solution:**

- (A) 465

Explanation:

Proportions or theorems are the statements that can be proved. Euclid deduced 465 proportions in a logical chain using his axioms, postulates, definitions and theorems.  
Hence, option (A) is the correct answer.

**7. Boundaries of solids are:**

- (A) Surfaces
- (B) Curves
- (C) Lines
- (D) Points

**Solution:**

- (A) Surfaces

Explanation:

The boundaries of solids are surfaces.  
Hence, option (A) is the correct answer.

**8. Boundaries of surfaces are:**

- (A) Surfaces
- (B) Curves
- (C) Lines
- (D) Points

**Solution:**

- (B) Curves

Explanation:

The boundaries of surfaces are curves.

Hence, option (B) is the correct answer.

**9. In Indus Valley Civilisation (about 3000 B.C.), the bricks used for construction work were having dimensions in the ratio**

- (A) 1 : 3 : 4
- (B) 4 : 2 : 1
- (C) 4 : 4 : 1
- (D) 4 : 3 : 2

**Solution:**

- (B) 4 : 2 : 1

Explanation:

In Indus Valley Civilisation (about 3000 B.C.), the bricks used for construction work were having dimensions in the ratio,

Length: breadth: thickness = 4:2:1

Hence, option (B) is the correct answer.

**10. A pyramid is a solid figure, the base of which is**

- (A) Only a triangle
- (B) Only a square
- (C) Only a rectangle
- (D) Any polygon

**Solution:**

- (D) Any polygon

Explanation:

A pyramid is solid figure, the base of which can be a triangle, a square or some other polygon.

Hence, option (D) is the correct answer.

**11. The side faces of a pyramid are:**

- (A) Triangles
- (B) Squares
- (C) Polygons
- (D) Trapeziums

**Solution:**

- (A) Triangles

Explanation:

The side faces of a pyramid are triangles.

Hence, option (A) is the correct answer.

## EXERCISE 5.2

Write whether the following statements are True or False? Justify your answer:

**1. Euclidean geometry is valid only for curved surfaces.**

**Solution:**

False

Justification:

The statement “Euclidean geometry is valid only for curved surfaces” is false because Euclidean geometry is valid only for the figures in the plane but on the curved surfaces it fails.

**2. The boundaries of the solids are curves.**

**Solution:**

False

Justification:

The statement “the boundaries of the solids are curves” is false because the boundaries of the solids are surfaces.

**3. The edges of a surface are curves.**

**Solution:**

False

Justification:

The statement “the edges of a surface are curves” is false because the edges of surfaces are lines.

**4. The things which are double of the same thing are equal to one another.**

**Solution:**

True

Justification:

The statement “the things which are double of the same thing are equal to one another” is true since, it is one of the Euclid’s axiom.

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## EXERCISE 5.3

Solve each of the following question using appropriate Euclid's axiom :

**1. Two salesmen make equal sales during the month of August. In September, each salesman doubles his sale of the month of August. Compare their sales in September.**

**Solution:**

Let the sale of both the salesmen in August =  $x$ .

According to the question, we have,

In September, each salesman doubles his sales of August.

Hence, we have,

In September,

Sales of first salesmen =  $2x$

And, sales of second salesman =  $2x$ .

According to Euclid's axioms, things which are double of the same things are equal to one another.

Therefore, in September their sales are again equal.

**2. It is known that  $x + y = 10$  and that  $x = z$ . Show that  $z + y = 10$ ?**

**Solution:**

According to the question,

We have,

$$x + y = 10 \dots (i)$$

$$\text{And, } x = z \dots (ii)$$

Applying the Euclid's axiom,

"if equals are added to equals, the wholes are equal"

We get,

From Eqs. (i) and (ii)

$$x + y = z + y \dots (iii)$$

From Eqs. (i) and (iii)

$$z + y = 10$$

**3. Look at the Fig. 5.3. Show that length  $AH >$  sum of lengths of  $AB + BC + CD$ .**



**Solution:**

According to the given figure, we have,

$$AB + BC + CD = AD$$

Here, AD is a part of AH.

According to Euclid's axiom,

"The whole is greater than the part"

i.e.,  $AH > AD$

Therefore, length  $AH >$  sum of the lengths of  $AB + BC + CD$ .

4. In the Fig.5.4, we have  $AB = BC$ ,  $BX = BY$ . Show that  $AX = CY$ .

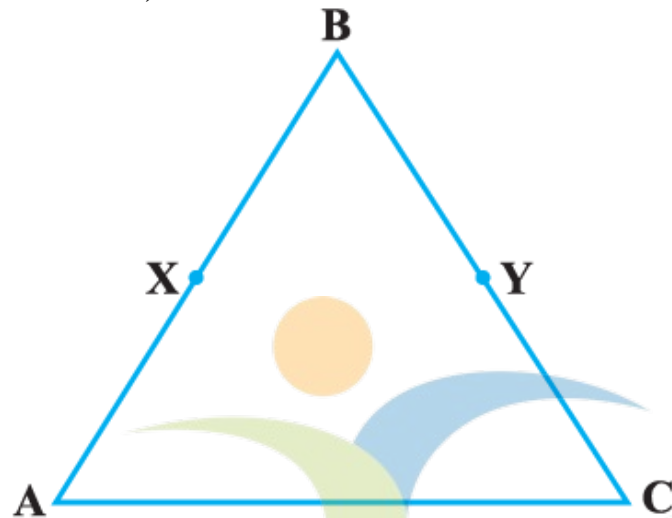


Fig. 5.4

**Solution:**

According to the question,

We have,

$AB = BC \dots (i)$

and  $BX = BY \dots (ii)$

According to Euclid's axiom,

"If equals are subtracted from equals, the remainders are equal."

Subtracting Eq.(ii) from (i),

We get,

$AB - BX = BC - BY$

$\Rightarrow AX = CY$  [from the given figure]

5. In the Fig.5.5, we have X and Y are the mid-points of AC and BC and  $AX = CY$ . Show that  $AC = BC$ .

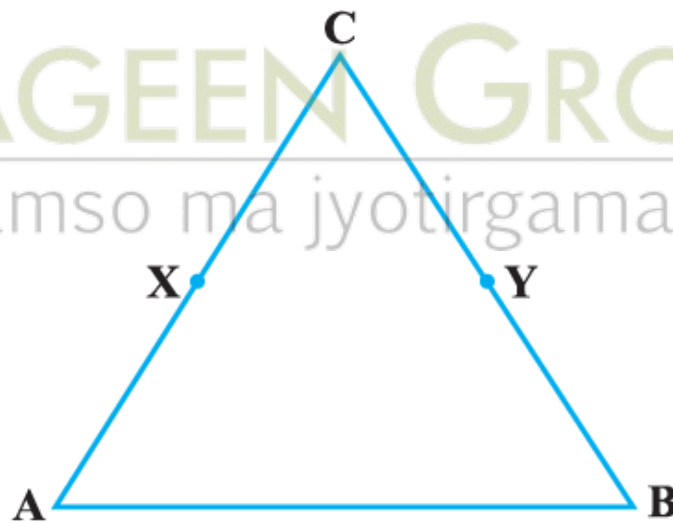


Fig. 5.5

**Solution:**

Given, X is the mid-point of AC

$$AX = CX = \frac{1}{2} AC$$

$$\Rightarrow 2AX = 2CX = AC \dots(i)$$

Y is the mid-point of BC.

$$BY = CY = \frac{1}{2} BC$$

$$\Rightarrow 2BY = 2CY = BC \dots(ii)$$

According to the question,

We also have,

$$AX = CY \dots(iii)$$

Applying the Euclid's axiom,

“Things which are double of the same things are equal to one another”.

We get,

From Eq. (iii),

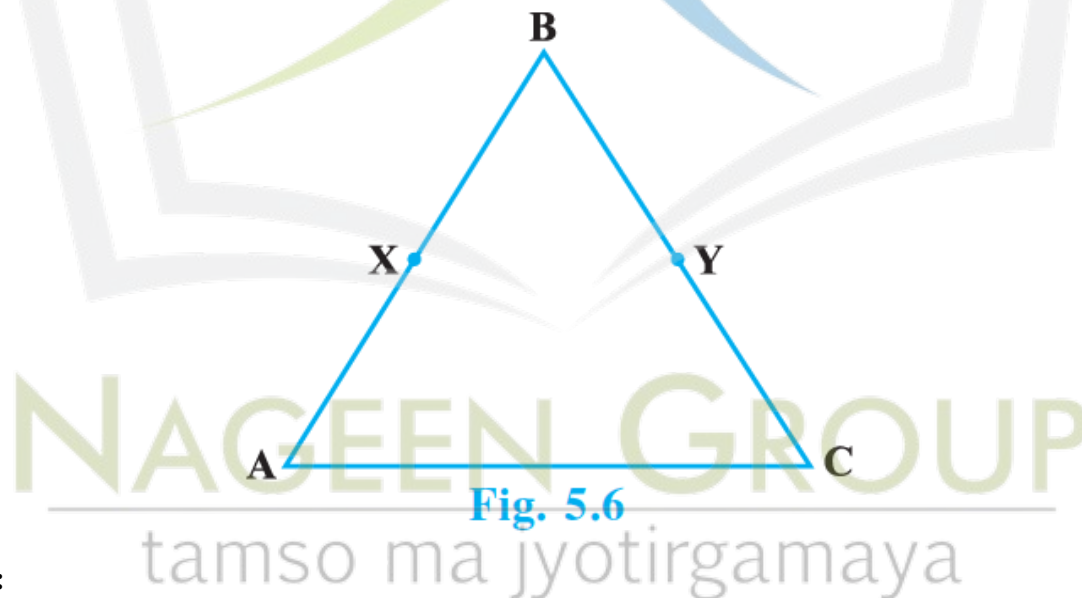
$$2AX = 2CY$$

Using Eqs. (i) and (ii), we get,

$$AC = BC$$

Hence Proved.

**6. In the Fig.5.6, we have  $BX = \frac{1}{2} AB$ ,  $BY = \frac{1}{2} BC$  and  $AB = BC$ . Show that  $BX = BY$ .**

**Solution:**

According to the question,

We have,

$$BX = \frac{1}{2} AB \text{ and } BY = \frac{1}{2} BC$$

$$\Rightarrow 2BX = AB \dots(i)$$

$$\Rightarrow 2BY = BC \dots(ii)$$

It is also given that,

$$AB = BC \dots(iii)$$

Substituting the values from Eqs. (i) and (ii) in eq. (iii), we get,

$$2BX = 2BY$$

Applying the Euclid's axiom, “things which are double of same things are equal to one another”.

$$BX = BY$$

## EXERCISE 5.4

### 1. Read the following statement:

**An equilateral triangle is a polygon made up of three line segments out of which two line segments are equal to the third one and all its angles are  $60^\circ$  each. Define the terms used in this definition which you feel necessary. Are there any undefined terms in this? Can you justify that all sides and all angles are equal in an equilateral triangle.**

#### **Solution:**

The terms need to be defined are.

i: Polygon: Polygon is a closed figure bounded by three or more-line segments.

ii: Line segment: A line segment is a part of line having two end points.

Undefined terms are:

i: Line: undefined term

ii: Point: undefined term

Let us see why line and point are undefined terms.

Angle: Angle in a figure is formed by two rays with one common initial point.

Acute angle: Acute angle is an angle whose measure is between  $0^\circ$  to  $90^\circ$ .

Hence, the undefined terms are line and point.

According to the question,

All the angles of equilateral triangle are  $60^\circ$  each (given)

Two-line segments are equal to third one (given)

Applying to Euclid's axiom, things which are equal to the same thing are equal to one another.

Therefore, all three sides of an equilateral triangle are equal.

### 2. Study the following statement:

**“Two intersecting lines cannot be perpendicular to the same line”.**

**Check whether it is an equivalent version to the Euclid's fifth postulate.**

**[Hint: Identify the two intersecting lines  $l$  and  $m$  and the line  $n$  in the above statement.]**

#### **Solution:**

Two equivalent version of Euclid's fifth postulate are:

- For every line  $l$  and for every point  $p$  not lying on  $l$ , there exists a unique line  $m$  passing through  $p$  and parallel to  $l$ .
- Two distinct intersecting lines cannot be parallel to the same line.

From these two statements, it is clear that the statement “two intersecting lines cannot be perpendicular to the same line” is not an equivalent version to the Euclid's fifth postulate.

## Chapter 5

### Introduction To Euclid's Geometry

#### Exercise 5.1

##### Question 1:

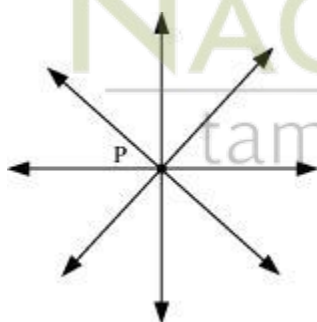
Which of the following statements are true and which are false? Give reasons for your **Answers**.

- (i) Only one line can pass through a single point.
- (ii) There are an infinite number of lines which pass through two distinct points.
- (iii) A terminated line can be produced indefinitely on both the sides.
- (iv) If two circles are equal, then their radii are equal.
- v) In the following figure, if  $AB = PQ$  and  $PQ = XY$ , then  $AB = XY$ .



##### Answer:

- (i) False. Since through a single point, infinite number of lines can pass. In the following figure, it can be seen that there are infinite numbers of lines passing through a single point P.



- (ii) False. Since through two distinct points, only one line can pass. In the following figure, it can be seen that there is only one single line that can pass through two distinct points P and Q.



(iii) True. A terminated line can be produced indefinitely on both the sides.

Let AB be a terminated line. It can be seen that it can be produced indefinitely on both the sides.



(iv) True. If two circles are equal, then their centre and circumference will coincide and hence, the radii will also be equal.

(v) True. It is given that AB and XY are two terminated lines, and both are equal to a third line PQ. Euclid's first axiom states that things which are equal to the same thing are equal to one another. Therefore, the lines AB and XY will be equal to each other.

### Question 2:

Give a definition for each of the following terms. Are there other terms that need to be defined first? What are they, and how might you define them?

(i) parallel lines (ii) perpendicular lines (iii) line segment

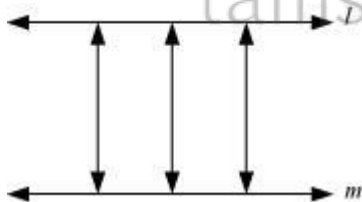
(iv) radius of a circle (v) square

**Answer:**

(i) Parallel Lines

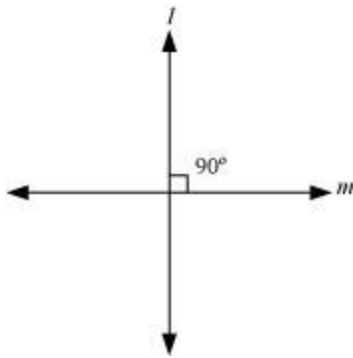
If the perpendicular distance between two lines is always constant, then these are called parallel lines. In other words, the lines which never intersect each other are called parallel lines.

To define parallel lines, we must know about point, lines, and distance between the lines and the point of intersection.



(ii) Perpendicular lines

If two lines intersect each other at  $90^\circ$ , then these are called perpendicular lines. We are required to define line and the angle before defining perpendicular lines.



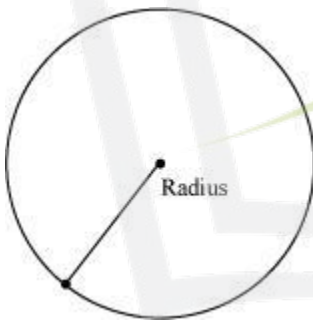
### (iii) Line segment

A straight line drawn from any point to any other point is called as line segment. To define a line segment, we must know about point and line segment.



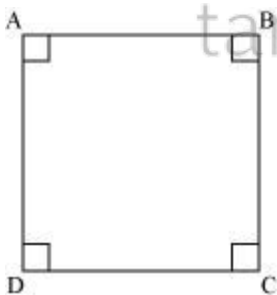
### (iv) Radius of a circle

It is the distance between the centres of a circle to any point lying on the circle. To define the radius of a circle, we must know about point and circle.



### (v) Square

A square is a quadrilateral having all sides of equal length and all angles of same measure, i.e.,  $90^\circ$ . To define square, we must know about quadrilateral, side, and angle.



### Question 3:

Consider the two 'postulates' given below:

(i) Given any two distinct points A and B, there exists a third point C, which is between A and B.

(ii) There exists at least three points that are not on the same line.

Do these postulates contain any undefined terms? Are these postulates consistent?

Do they follow from Euclid's postulates? Explain.

**Answer:**

There are various undefined terms in the given postulates.

The given postulates are consistent because they refer to two different situations. Also, it is impossible to deduce any statement that contradicts any well known axiom and postulate.

These postulates do not follow from Euclid's postulates. They follow from the axiom, "Given two distinct points, there is a unique line that passes through them".

**Question 4:**

If a point C lies between two points A and B such that  $AC = BC$ , then prove that

$AC = \frac{1}{2}AB$ . Explain by drawing the figure.

**Answer:**

It is given that,

$$AC = BC$$



$$AC + AC = BC + AC \quad (\text{Equals are added on both sides}) \dots (1)$$

Here,  $(BC + AC)$  coincides with  $AB$ . It is known that things which coincide with one another are equal to one another.

$$\therefore BC + AC = AB \dots (2)$$

It is also known that things which are equal to the same thing are equal to one another. Therefore, from equations (1) and (2), we obtain

$$AC + AC = AB$$

$$2AC = AB$$

$$\therefore AC = \frac{1}{2} AB$$

**Question 5:**

In the above **Question**, point C is called a mid-point of line segment AB, prove that every line segment has one and only one mid-point.

**Answer:**

Let there be two mid-points, C and D.



C is the mid-point of AB.

$$AC = CB$$

$$AC + AC = BC + AC \quad (\text{Equals are added on both sides}) \dots (1)$$

Here,  $(BC + AC)$  coincides with AB. It is known that things which coincide with one another are equal to one another.

$$\therefore BC + AC = AB \dots (2)$$

It is also known that things which are equal to the same thing are equal to one another. Therefore, from equations (1) and (2), we obtain

$$AC + AC = AB$$

$$\Rightarrow 2AC = AB \dots (3)$$

Similarly, by taking D as the mid-point of AB, it can be proved that

$$2AD = AB \dots (4)$$

From equation (3) and (4), we obtain

$$2AC = 2AD \quad (\text{Things which are equal to the same thing are equal to one another.})$$

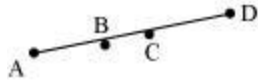
$$\Rightarrow AC = AD \quad (\text{Things which are double of the same things are equal to one another.})$$

This is possible only when point C and D are representing a single point.

Hence, our assumption is wrong and there can be only one mid-point of a given line segment.

**Question 6:**

In the following figure, if  $AC = BD$ , then prove that  $AB = CD$ .



**Answer:**

From the figure, it can be observed that

$$AC = AB + BC$$

$$BD = BC + CD$$

It is given that  $AC = BD$

$$AB + BC = BC + CD \quad (1)$$

According to Euclid's axiom, when equals are subtracted from equals, the remainders are also equal.

Subtracting  $BC$  from equation (1), we obtain

$$AB + BC - BC = BC + CD - BC$$

$$AB = CD$$

**Question 7:**

Why is Axiom 5, in the list of Euclid's axioms, considered a 'universal truth'? (Note that the **Question** is not about the fifth postulate.)

**Answer:**

**Axiom 5** states that the whole is greater than the part. This axiom is known as a universal truth because it holds true in any field, and not just in the field of mathematics. Let us take two cases – one in the field of mathematics, and one other than that.

**Case I**

Let  $t$  represent a whole quantity and only  $a, b, c$  are parts of it.

$$t = a + b + c$$

Clearly,  $t$  will be greater than all its parts  $a$ ,  $b$ , and  $c$ .

Therefore, it is rightly said that the whole is greater than the part.

### Case II

Let us consider the continent Asia. Then, let us consider a country India which belongs to Asia. India is a part of Asia, and it can also be observed that Asia is greater than India. That is why we can say that the whole is greater than the part. This is true for anything in any part of the world and is thus a universal truth.



## INTRODUCTION TO EUCLID'S GEOMETRY

## MIND MAP



Axiomatic system, in which all theorems are derived from a small number of axioms

Euclid's Geometry

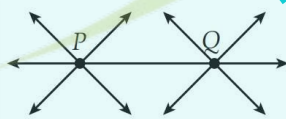
Introduction to Euclid's Geometry

Euclid's Postulates

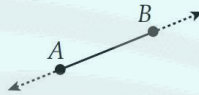
Definitions

Euclid's Axioms

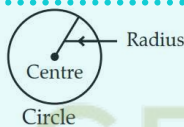
1 A straight line can be drawn from any one point to any other point.



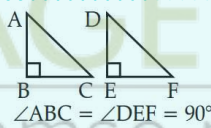
2 A terminated line can be produced infinitely.



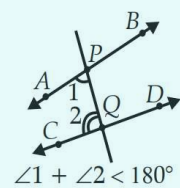
3 A circle can be drawn with any centre and of any radius.



4 All right angles are equal to one another.



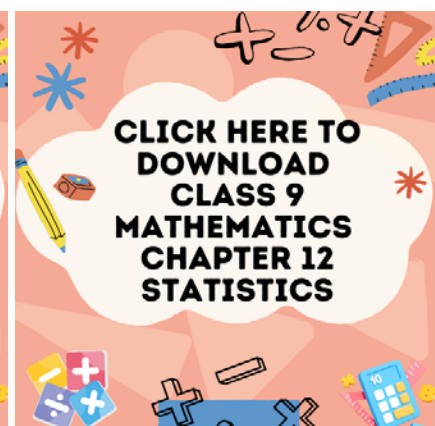
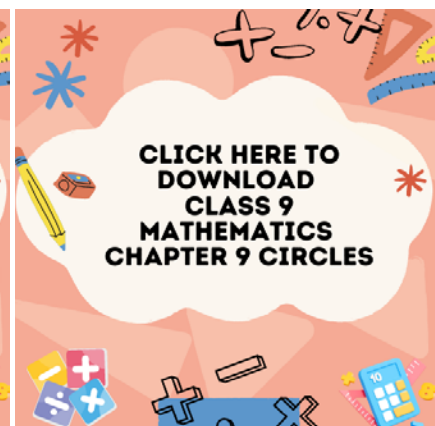
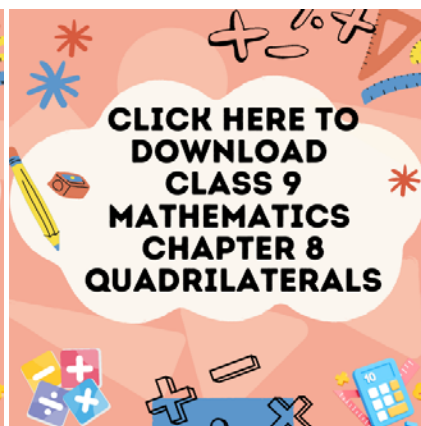
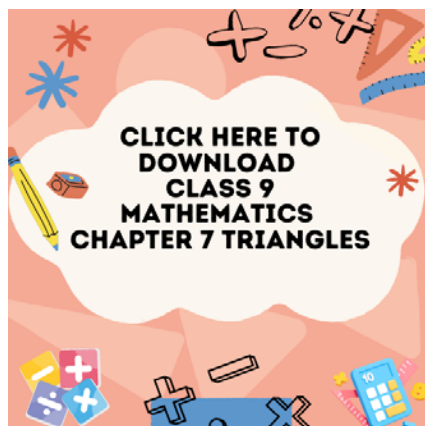
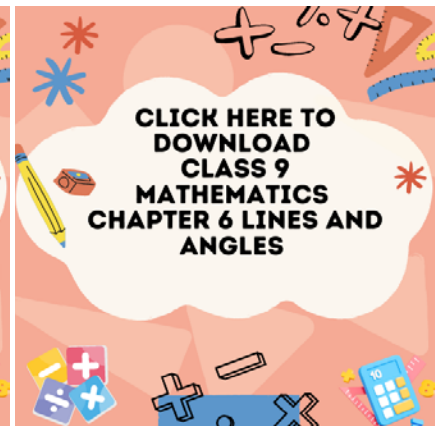
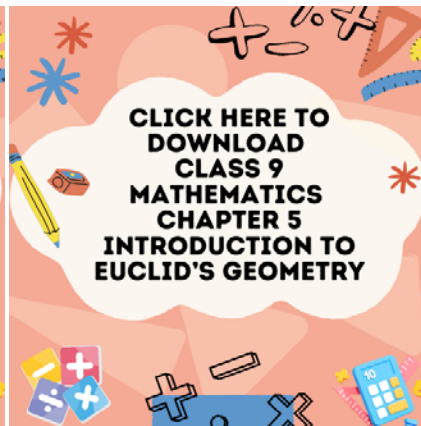
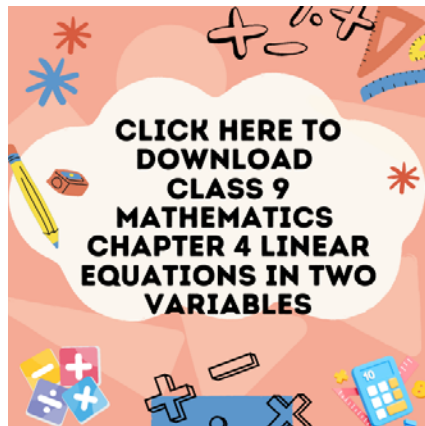
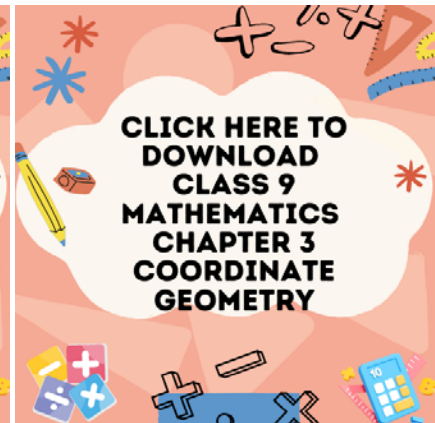
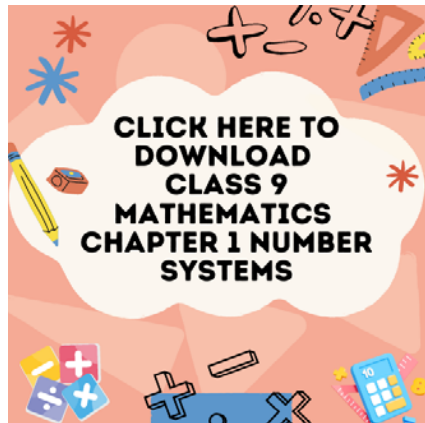
5 If a straight line falling on two straight lines makes the interior angles on the same side of it, taken together makes less than two right angles, then the two straight lines, if produced indefinitely, meet on that side on which the sum of the angles is less than two right angles.



Point	Has no width, no length and no depth	 Point
Line	Collection of points, can be extended in both directions.	 Line
Surface	Two - dimensional collection of points (has length & breadth only)	 Surface

1	Things which are equal to the same thing are equal to one another.
2	If equals are added to equals, wholes are equal.
3	If equals are subtracted from equals, the remainders are equal.
4	Things which coincide with one another are equal to one another.
5	The whole is greater than the part.
6	Things which are double of the same things are equal to one another.
7	Things which are halves of the same things are equal to one another.

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4. Distribute WhatsApp group resources among your students.
5. Encourage your colleagues to join these groups.

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2. After sharing resources with students, consider deleting outdated data if necessary.
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  - No greetings or wish messages.
  - No personal chats or messages.
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Artificial Intelligence



Beauty & Wellness



Design Thinking & Innovation



Financial Literacy



Handicrafts



Information Technology



Marketing/Commercial Application



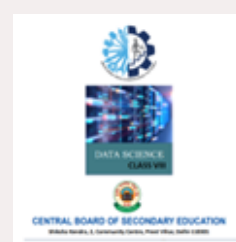
Mass Media - Being Media Literate



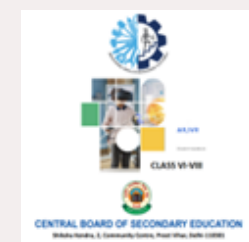
Travel & Tourism



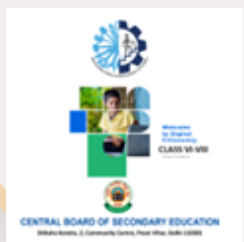
Coding



Data Science (Class VIII only)



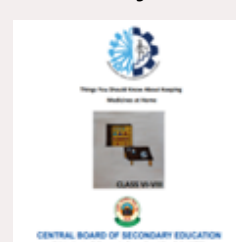
Augmented Reality / Virtual Reality



Digital Citizenship



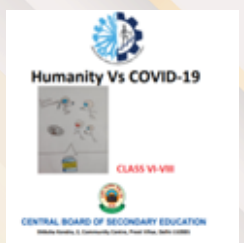
Life Cycle of Medicine & Vaccine



Things you should know about keeping Medicines at home



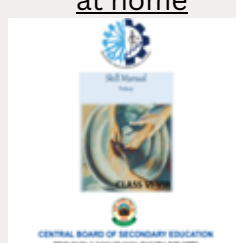
What to do when Doctor is not around



Humanity & Covid-19



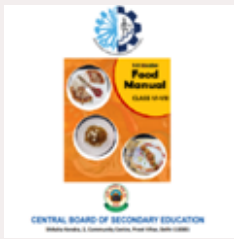
Blue Pottery



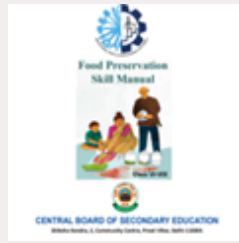
Pottery



Block Printing



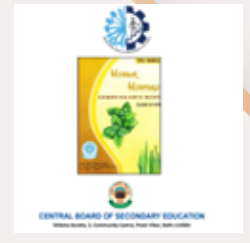
Food



Food Preservation



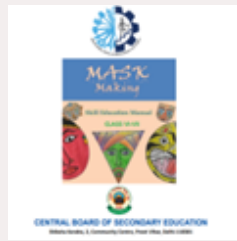
Baking



Herbal Heritage



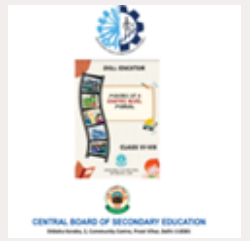
Khadi



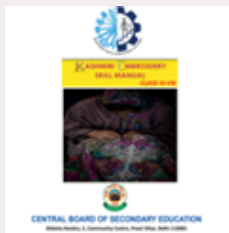
Mask Making



Mass Media



Making of a Graphic Novel



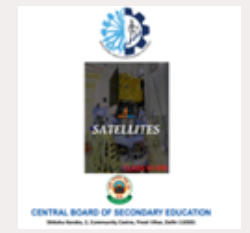
Kashmiri Embroidery



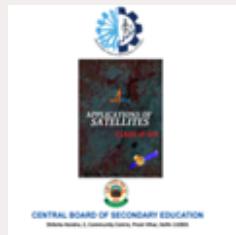
Embroidery



Rockets



Satellites



Application of Satellites

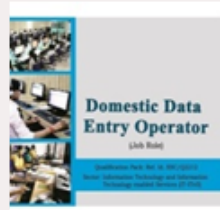


Photography

# SKILL SUBJECTS AT SECONDARY LEVEL (CLASSES IX – X)



Retail



Information Technology



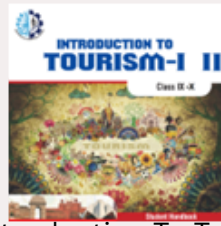
Security



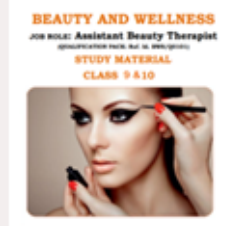
Automotive



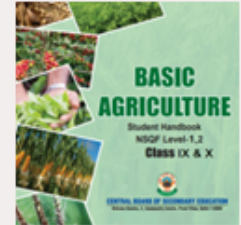
Introduction To Financial Markets



Introduction To Tourism



Beauty & Wellness



Agriculture



Food Production



Front Office Operations



Banking & Insurance



Marketing & Sales



Health Care



Apparel



Multi Media



Multi Skill Foundation Course



Artificial Intelligence



Physical Activity Trainer



Data Science



Electronics & Hardware (NEW)

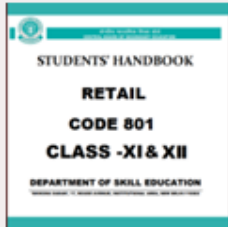


Foundation Skills For Sciences (Pharmaceutical & Biotechnology)(NEW)

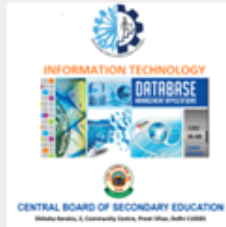


Design Thinking & Innovation (NEW)

# SKILL SUBJECTS AT SR. SEC. LEVEL (CLASSES XI – XII)



Retail



Information Technology



Web Application



Automotive



Financial Markets Management



Tourism



Beauty & Wellness



Agriculture



Food Production



Front Office Operations



Banking



Marketing



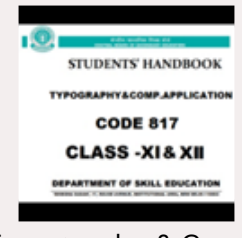
Health Care



Insurance



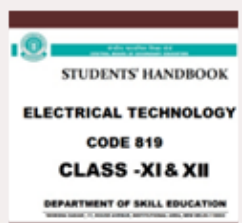
Horticulture



Typography & Comp.  
Application



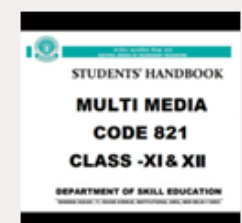
Geospatial Technology



Electrical Technology



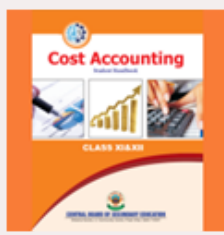
Electronic Technology



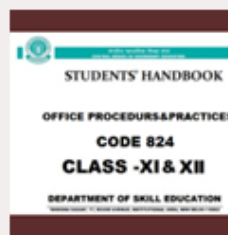
Multi-Media



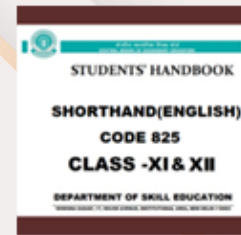
Taxation



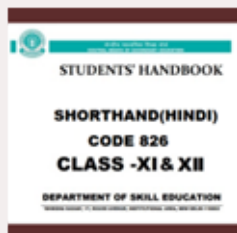
Cost Accounting



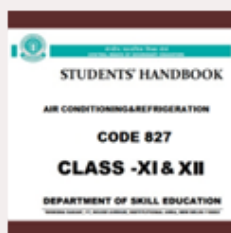
Office Procedures & Practices



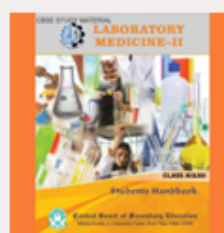
Shorthand (English)



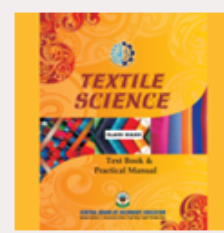
Shorthand (Hindi)



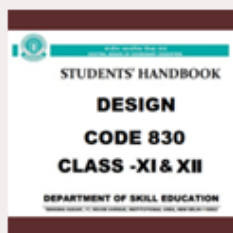
Air-Conditioning & Refrigeration



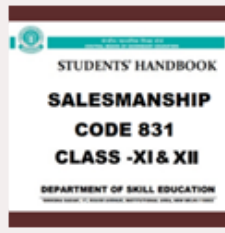
Medical Diagnostics



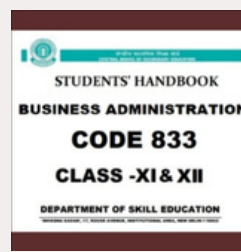
Textile Design



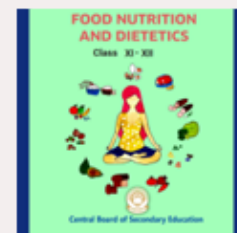
Design



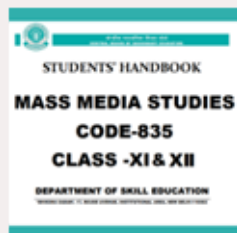
Salesmanship



Business Administration



Food Nutrition & Dietetics



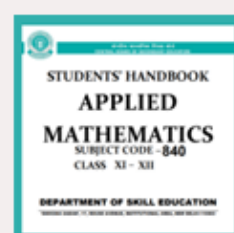
Mass Media Studies



Library & Information Science



Fashion Studies



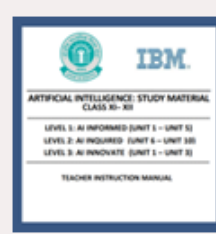
Applied Mathematics



Yoga



Early Childhood Care & Education



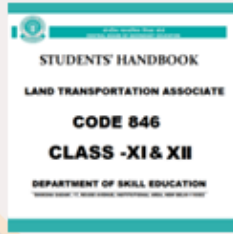
Artificial Intelligence



Data Science



Physical Activity Trainer(new)



Land Transportation Associate (NEW)



Electronics & Hardware (NEW)



Design Thinking & Innovation (NEW)

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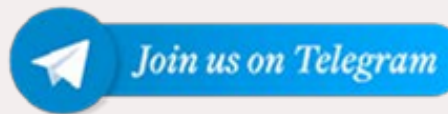
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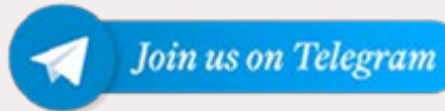
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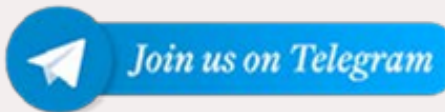
All classes



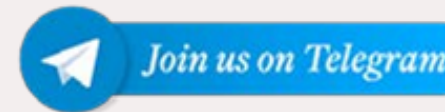
Class 1



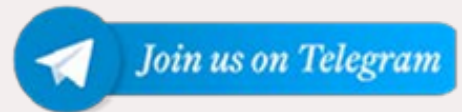
Class 2



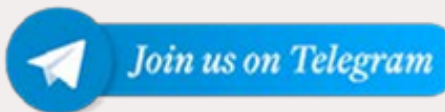
Class 3



Class 4



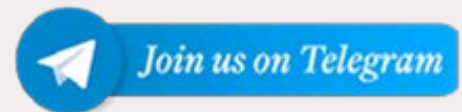
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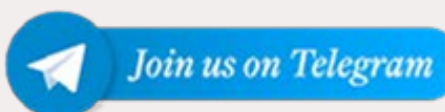
Class 6



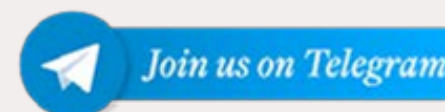
Class 7



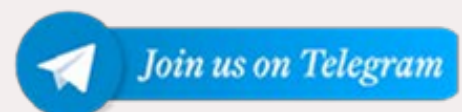
Class 8



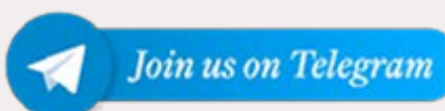
Class 9



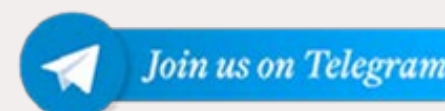
Class 10



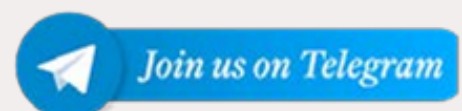
Class 11 (Sci)



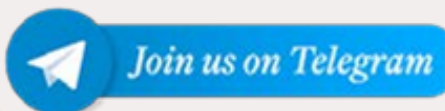
Class 11 (Com)



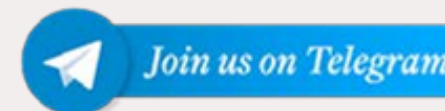
Class 11 (Hum)



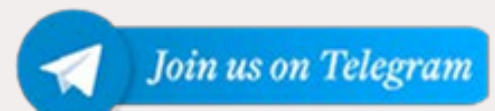
Class 12 (Sci)



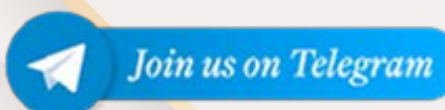
Class 12 (Com)



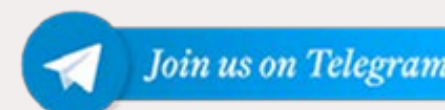
Class 12 (Hum)



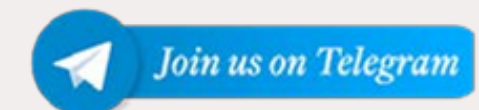
JEE/NEET



CUET



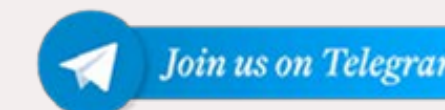
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Principal Professional Group



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